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Acute Care Outcome Measures In A Patient Status-Post Right Total Knee Arthroplasty (TKA) Following A Left TKA Staged Five Weeks Apart: A Case Report

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The patient signed an informed consent allowing the use of medical information and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

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Abstract:

Background and Purpose: Total knee arthroplasty (TKA) is one of the most frequently performed orthopedic procedures in the U.S. Thousands of people undergo TKA every year in hopes of improving their functional abilities and reducing their pain levels. The purpose of this case report was to document acute care outcome measures in a patient who underwent bilateral TKA staged five weeks apart and to assess the possible implications that a short staging period might have on the patient's ability to recover. **Case Description**: The patient was a 58-year-old male who following a left TKA underwent a right TKA, secondary to right knee osteoarthritis. The patient received physical therapy twice daily until he was appropriate for a safe discharge home. Therapeutic exercises were provided based on the hospital's post-operative TKA protocol. The patient also underwent functional mobility training. **Outcomes**: Right knee range of motion (ROM), strength, sensation, pain, ability to perform a straight leg raise (SLR) and functional abilities were assessed. The patient's right knee ROM at discharge was 2 degrees of extension to 70 degrees of flexion. The patient never gained the ability to independently perform a SLR prior to discharge. He was however, able to safely perform functional mobility tasks without right knee buckling and without loss of balance with the use of a walker at discharge. **Discussion**: Many studies support an early and intensive post-operative rehabilitation program. Recommended exercise guidelines in the acute care setting following a TKA, as well as the optimal staging period between bilateral TKA, are limited. Further research is needed to determine the most beneficial exercises, frequency, intensity, and duration in order to produce the best functional outcomes.

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Background/Purpose:

Osteoarthritis (OA) is the most prevalent form of arthritis.[1,2,3,4] It most commonly affects the hip and knee joints.[3] The prevalence of knee OA increases with age, female gender, loss of bone density, nutritional deficiencies, muscular weakness, misalignment of the knee joint and obesity.[1,2] Traditionally, it has been considered a disease of articular cartilage; however research now shows that it is a disease of the entire joint.[1,2] OA can result in pain, swelling, stiffness, and sometimes bone spur formation.[1] Although there is no cure, current treatment strategies for knee OA include conservative treatment (pharmacological and non-pharmacological) and surgical treatment for when patients fail to respond to conservative measures.[3]

Osteoarthritis is the most common reason for a total knee arthroplasty (TKA).[2,4] TKA is the most common orthopedic procedure in the U.S., and it has been shown to reduce pain, improve functional mobility and increase quality of life.[4,5] The TKA procedure involves the replacement of both joint surfaces with metal alloy components that recreate the joint surface.[4] Individuals can undergo a simultaneous, unilateral, or staged TKA. Risk and benefits have been associated with each option. There is a lack of specific evidence regarding the optimal time-frame between bilateral TKA, if a patient is not deemed an appropriate candidate for a simultaneous TKA.[6] It has been recommended that a second TKA be performed at least three months after the original surgery.[6] Evidence suggests that staging bilateral TKA within three months of each other may increase the patient's risk for mortality and complications.[6]

After a TKA procedure is performed, patients are referred to physical therapy (PT) in order to restore function; however recommended guidelines that produce the best acute care outcomes are limited. The purpose of this case report was to report on acute care outcome measures in a patient who underwent bilateral TKA staged five weeks apart. This case report is needed because it will examine the possible implications that a short staging period might have on the patient's ability to recover. It will also take into account the hospital's post-operative protocol that was implemented throughout the duration of the patient's acute care stay.

Case Description

Patient History:

The patient was a 58-year-old male seen in the acute care setting status post right TKA, following PT referral by his orthopedic surgeon. Prior to the initial examination (IE), the patient signed all consent to treat forms. The patient's history revealed that he was an active, healthy, white male who had a long-standing history of bilateral knee pain. He attributed the arthritis in his knees to previously working as a carpenter, as well as working as a manual laborer in a factory many years ago. The patient received bilateral cortisone injections on two different occasions, both within six months prior to surgery, reporting that the most recent injection did not relieve his pain. X-rays revealed bilateral osteoarthritis of the knees. He was deemed an appropriate candidate to receive staged, bilateral TKA. He underwent a left TKA and received PT within his home for a couple weeks, prior to attending outpatient PT. The patient returned five weeks later to undergo a right TKA.

The patient worked as a high school woodshop teacher. He lived in a two-story home with his supportive wife. There were no stairs to enter his home and all of his needs were met on the first floor. The patient was in good health with no significant past medical history (PMH). He reported smoking half to three quarters of a pack of cigarettes per day. He was independent with his activities of daily living and instrumental activities of daily living, without the use of an assistive device (AD) at baseline; however activities were limited due to pain.

Prior to surgery, the patient had difficulty donning and doffing his socks and shoes and reported having to use a long-handled shoe horn for assist. He had difficulty ascending and descending stairs, walking on hard surfaces, and walking long distances. His ability to function at work was limited. His knee pain prevented him from being able to lift heavy objects, stand for long periods of time, and interact with students the way he normally would. For years he had also been unable to go biking, something he really enjoyed doing. The patient's goal was to regain functional mobility in order to return to work. PT was ordered to help the patient return to a functional level status-post right TKA in order to allow him to safely return home and to work.

Systems review:

The PT IE began in the afternoon on post-operative day zero. The patient had received a right LE continuous femoral nerve block (CFNB). A CFNB is a form of anesthesia that helps with post-operative pain control.[7,8] However, due to the femoral nerve innervation pattern, many patients still experience pain in the posterior capsule of the knee.[8] Femoral nerve blocks can impair motor control of the quadriceps muscle, therefore putting the patient at an increased risk for falls.

The patient had full weight-bearing orders on the right lower extremity (LE), post-operatively; however, the surgeon ordered that the patient wear a knee immobilizer (KI) during out of bed mobility to help stabilize the knee until quadriceps function was restored. The physical therapist (PT) was able to discontinue the use of the KI once the patient demonstrated adequate quadriceps function or if on day of discharge it was deemed appropriate. Adequate quadriceps function was based on whether or not the patient could actively life the right LE off the surface of the bed without flexing the knee, otherwise known as having a positive straight leg raise (SLR).

A complete systems review was performed at the IE (see Table 1). Right LE range of motion (ROM), strength, sensation, skin integrity and functional mobility were all impaired. Although the patient had a TKA procedure done on his left knee five weeks prior, the examination revealed that he had regained full function of that extremity.

Clinical Impression 1:

There were no differential diagnoses as X-rays revealed OA of both the left and right knees. The patient was an appropriate candidate for a staged bilateral TKA due to his diagnosis, good overall health, active lifestyle, motivation, family support, and failure of conservative treatment. Due to the patient's recent left TKA and primary right TKA, it was hypothesized that the patient would present with impaired bilateral LE ROM, strength, balance, sensation, skin integrity, and functional mobility.

In order to confirm the hypothesis, the plan for the IE was to attain a thorough history, obtain orthostatic measurements, assess his pain levels, test his bilateral LE dermatomes, perform manual muscle testing (MMT) of both legs in order to determine his strengths and weaknesses, functionally assess his left knee ROM, and obtain more specific measurements of the right knee ROM. Part of the IE also included

teaching the patient LE exercises that followed the hospital's post-operative TKA protocol (see Appendix 6), along with assessing his bed mobility, ability to transfer, and analyzing his gait pattern (see Table 4).

The patient was a good candidate for this case report due to the short staging period between each TKA and the affects this might have had his acute care outcome measures. Due to the lack of nationally recommended acute care guidelines and limited protocols in the literature, the patient had the potential to provide useful information regarding the protocol that was used.

Examination: Tests & Measures

After a thorough history was obtained and systems review was performed, the therapist proceeded with tests and measures in order to gain additional information (see table 2). Tests and measures were chosen based on the impairments found during the systems review.

At the IE, it was determined that the patient's left LE had regained full function (ROM, strength, sensation) since the time of his surgery, and would be used as a baseline for comparison to the right LE. Active assisted range of motion (AAROM) of the right knee was measured using a goniometer, with the patient in supine as described by Norkin and White.[9]

Gross strength of the right LE was tested in supine and sitting. The lack of strength in the right LE at the IE was likely due to the CFNB that the patient had received. Due to the patient's inability to demonstrate adequate quadriceps control during a SLR, he was required to wear a KI on his right LE for out of bed mobility, per the physician's orders.

The patient's right LE touch awareness, tactile localization, and pressure perception were all assessed using the therapist's finger at random locations along the dermatome distribution, as described in O'Sullivan and Schmitz.[13] Sensation was difficult to accurately assess due to the bulky post-operative dressing.

Throughout the IE, the patient's pain levels were assessed using the numerical rating scale (NRS). The NRS is an 11, 21, or 101 point scale where the end points represent no pain and worst pain.[12] The NRS is quick to administer and easy to use.[12] The patient was asked to rate his level of pain using the 11

point scale at rest, post-therapeutic exercise and post ambulation. His reported "acceptable" level of pain was also obtained.

Clinical Impression 2:

Evaluation:

The therapist's initial clinical impression was that the patient would present with impaired bilateral LE ROM, strength, balance, sensation, skin integrity, and functional mobility. Based on the examination findings, the initial impression was partially confirmed. The patient presented with impaired functional mobility (bed mobility, transfers and gait) due to impaired balance, decreased right LE strength, ROM and sensation, increased pain and decreased tolerance for activity at the IE. The left LE, however, appeared to be fully functioning despite his recent left TKA. At the time of the IE, the patient required assist from the therapist, use of an AD, and a KI for stabilization. The patient continued to be appropriate for the case due to his continued pain and limited functional mobility, both of which were preventing him from being able to function safely within the home, community, and at work.

Diagnosis:

Refer to Appendix 1 for a list of the patient's diagnoses and corresponding ICD-9 codes.[15]

Prognosis:

The patient had a good prognosis for improvement with PT. His left TKA had no complications and he had regained functional strength and ROM, prior to receiving his right TKA. This showed that he was motivated and willing to work with PT, in order to receive similar outcomes. He also had an unremarkable PMH, led an active lifestyle, had a good support system, and appeared healthy at the time of the IE. There were, however, two primary concerns that had potential to affect his prognosis. If the left TKA was not fully healed and ready to "compensate" for the surgical insult on the right LE, this could have potentially affected the time frame in which the patient would meet his anticipated goals. The patient also reported smoking half to three quarters of a pack of cigarettes per day which had potential to delay the healing process of his right TKA. Despite the two primary concerns, the patient's prognosis remained

good. The patient was predicted to achieve a functional mobility level within three days that would allow him to safely return home, with PT services, upon discharge.

According to Bitar et al.,[16] the standard of care is to now provide rehabilitation protocols as early as possible in order to promote earlier activity and mobilization of patients and decrease their length of stay (LOS). The current average acute care LOS in the U.S. for a unilateral TKA is 3.7 days due to better medical management and fewer complication rates.[16] Factors that may increase a patient's LOS or likelihood of being discharged to a rehabilitation unit include older age, diabetes, Hispanic race, weekend admission, rural non-teaching hospital, and complications.[16,17] The patient did not have any of these predisposing factors, and was therefore predicted to be discharged home on post-operative day two.

Plan of care:

The patient's plan of care (POC) involved proceeding with procedural interventions. There was no need for referral or further testing. The patient's procedural interventions were developed to reflect the patient's discharge goals (see Appendix 2).

Coordination, communication, documentation:

Coordination, communication, and documentation were an on-going process throughout the patient's acute care stay (see Table 5).

Patient/client related information:

On the day of the initial examination, the patient was educated on his PT POC, the importance of achieving right knee ROM, how to use the cryocuff machine* (see Appendix 3), and his discharge plan (see Table 6).

Procedural interventions:

The orthopedic surgeon requested PT and occupational therapy (OT) services for the patient. The patient's POC included receiving PT services twice daily, once in the morning and once in the afternoon until discharge. The patient fully participated in all PT treatment sessions. The surgeon ordered that the

* DJO, LLC. 1430 Decision Street, Vista, CA 92081

patient use a continuous passive motion (CPM) machine[†] twice a day for two hours each or until he could no longer tolerate it (see Appendix 4). The effects of CPM on knee ROM and pain post-TKA have been largely debated.[18] According to a systematic review done by Harvey et al.,[18] CPM does not have clinically important effects on active knee ROM, pain, function, or quality of life. Due to the large portion of current research that refutes the benefits of CPM use, hospitals should consider eliminating the use of CPMs post-operatively if its routine use cannot be justified.

Procedural interventions focused on the progression of therapeutic exercises (see Table 3) and functional mobility training (see Table 4). The patient began each PT treatment session with LE therapeutic exercises in supine. Mizner et al.[19] state that isometric exercises and active assisted exercises (similar to those used in the post-operative protocol) initiate strengthening and prevent secondary complications such as deep vein thrombosis. LE therapeutic exercises help to restore the ability to participate in functional mobility tasks.[19] The exercises appeared to improve circulation, strengthen targeted muscles, increase knee ROM, enhance the patient's functional capacity/endurance, and enable ambulation. Adequate strength in the quadriceps and hamstring muscles and knee ROM are important for functional mobility. The knee has to be able to achieve at least 0 to 60 degrees of motion in order to allow for a normalized gait pattern and the knee must flex to approximately 90 degrees in order to ascend/descend stairs and to be able to go from sit to and from stand.[20] Loss of knee ROM can result in an antalgic gait pattern or the inability to perform ordinary tasks.

It is important to work on everyday tasks such as bed mobility, transfers, ambulation and stairs so that a patient can, ideally, return to a prior level of function within their home and around the community upon discharge. At each visit, the patient practiced getting in and out of bed independently, going from sit-to-stand with safe hand placements and walking with the use of a FWW[‡] and correct sequencing. Each session he attempted to progress his ambulation distance; however, he was limited on post-operative day one due to pain. Less verbal cues and visual demonstrations were provided at each sequential visit, due to

[†] Orthologic Canada LTD, 901 Dillingham Road, Pickering, ON, L1W 2Y5, Canada
[‡] Medline Industries, Inc. 1 Medline Place, Mundelein, IL, 60060

adequate carry over and progress. On post-operative day two, he was able to practice getting in and out of a car using the car simulator[§] (see Appendix 5) in order to ensure a safe discharge plan home.

There is an opportunity to re-evaluate the standard approach to acute care PT status-post TKA. It seems as though PT has been largely based on targeting impairments and helping patients recover from the effects of surgery rather than targeting activity limitations and participation restrictions.[21] Current recommended guidelines follow TKA in the acute care setting are lacking; however many studies have found that earlier mobilization and an intense rehabilitation program greatly improves patient outcomes in the acute care setting.[16,22,23,24,25,26]

A study that was done by Labraca et al.[26] looked at the benefits of starting rehabilitation within 24 hours of a TKA. The study used a protocol very similar to the one used in this case report and found that the hospital length of stay mean and number of rehabilitation sessions needed to achieve autonomy and normal gait and balance were reduced.[26] The early onset of treatment reduced pain and improved knee ROM and LE muscle strength. Another study looked at the effects of a "fast-track" rehabilitation program versus a "standard" rehabilitation program.[25] The major difference between the two programs was the timing in which PT started after surgery and the duration of the sessions. Evidence showed that those who participated in the fast-track rehabilitation group showed an enhanced physical recovery, reduced drug intake, and reduced LOS compared with the standard rehabilitation group. Both studies strongly support the early treatment that was provided to the patient starting on post-operative day zero and shows strong correlations with improved functional outcomes.

The types of exercises and activities that patients should perform post-TKA in the acute care setting are still largely debated. Meire et al.[22] found that more progressive and higher intensity exercises may be necessary to address LE strength and functional mobility following surgery. According to Minns et al.,[21] interventions that focus on functional activities are more beneficial than exercises that focus on isometric contractions and increasing ROM after a TKA.

[§] Advanced Therapy Products, Inc. P.O. Box 3420, Glen Allen, VA 23058-3420

Morri et al.[23] looked at the effects of post-operative TKA rehabilitation in the acute care setting. The study found that patients who started performing functional activities earlier during their acute care stay, achieved greater autonomy at discharge. Post-operative protocols, which involve early and intense rehabilitation, are being applied more often in order to achieve greater autonomy in a shorter LOS.[23] This study supports high intensity activities, such as functional mobility exercises beginning on post-operative day zero, in order to produce the best outcomes.

Outcomes:

In order to maximize reliability of testing, the same PT performed both admission and discharge tests and measures (see Table 2). The discharge examination showed that the patient was independent with all functional mobility tasks with the use of a FWW, except for car transfers in which he required supervision, due to the fact that it was his first time performing it (see Table 4). Although the patient showed minimal right knee flexion and extension improvements, his ROM was within functional limits that allowed him to perform bed mobility, transfers and ambulation. The patient was able to ambulate without right knee buckling upon discharge. He demonstrated good understanding of fall prevention strategies and right LE supine and sitting therapeutic exercises. Although he did not meet all of his PT goals by post-operative day two, he demonstrated safe techniques and reported his wife would be able to assist him as necessary upon discharge home. Due to his continued impairments, activity limitations, and participation restrictions, it was recommended the patient receive PT services within his home upon discharge.

Discussion:

This case report described the acute care outcome measures in a patient who underwent bilateral TKA staged five weeks apart. It documented the possible implications that a short staging period might have on the patient's ability to recover, as well as the hospital's post-operative protocol that was implemented throughout the duration of the patient's stay. Literature is limited regarding the ideal staging period between bilateral TKA and beneficial post-operative exercise protocols. Due to the absence of

nationally recommended rehabilitation guidelines following a TKA in the acute care setting, this case was based on the PT's clinical judgement, as well as the patient's clinical goals.

The patient made good progress during his three day stay in the acute care setting. The primary focus on therapeutic exercises and functional mobility was appropriate. The patient had activity limitations and participation restrictions due to limited right knee ROM and strength, status-post right TKA. Factors that may have positively influenced his outcomes include the early onset of therapy, the interventions provided, the short staging period, his young age and motivation, and his insignificant PMH. Negative factors that could have affected the patient's outcomes include increased right knee pain on post-operative day one, the short staging period, history of smoking, as well as the types of interventions provided.

With TKA being one of the most common orthopedic procedures performed in the U.S., and with the increasing number of TKA procedures being performed each year, it is imperative more research is done regarding acute care rehabilitation. Bandholm and Kehlet[24] have proposed changing the focus of post-operative TKA rehabilitation to an earlier and more intensive program, in order to reduce loss of muscle strength and function after surgery. Further research is warranted to explore the optimal staging period between bilateral TKA, as well as which therapeutic exercises and functional mobility training interventions should be included in a post-operative TKA rehabilitation program. Specifics regarding frequency, intensity and duration of therapy need to be tested and evaluated in order to develop the most beneficial rehabilitation program.

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Table 1: Post-operative Systems Review

Cardiovascular/Pulmonary	
Not impaired	Orthostatics: BP supine: 143/87 mmHg HR: 79 bpm BP sitting: 137/92 mmHg HR: 83 bpm BP standing: 144/85 mmHg HR: 80 bpm
Musculoskeletal	
Impaired	Height: 68.90 inches Weight: 160 pounds BMI: 24 kg/m^2 Left LE ROM: WFL Right LE ROM: limited Left LE gross strength: WFL Right LE gross strength: limited
Neuromuscular	
Impaired	Left LE muscle tone: normal Right LE muscle tone: normal Left LE light-touch sensation: intact Right LE light-touch sensation: impaired Sitting balance: good Standing balance: impaired but good with use of FWW
Integumentary	
Impaired	Unable to assess incision site due to post-operative dressing. Patient had good bilateral LE skin color. Swelling was noted in right knee however unable to measure right knee circumference due to bulky post-operative dressing.
Communication, Affect, Cognition and Learning Style	
Not impaired	Patient was pleasant, cooperative, and spoke English. He was alert and oriented x4 (person, place, time, and situation). Cognition was intact. No learning barriers noticed. Pt reported he learned best through explanations, demonstrations and pictures.

Blood pressure (BP), millimeter of mercury (mmHg), heart rate (HR), beats per minute (bpm), body mass index (BMI), lower extremity (LE), within functional limits (WFL), range of motion (ROM), front wheel walker (FWW)

Table 2: Measurements of Acute Care Outcomes at Admission and Discharge

Tests & Measures	Initial Examination Results Postoperative day zero	Day of Discharge Results Postoperative day two	Psychometric Values
Range of Motion			
Right knee flexion	71 degrees	70 degrees	Goniometry of the knee: reliable and valid; however, intratester
Right knee extension	4 degrees	2 degrees	

			reliability is higher than intertester reliability.[9]
Muscle Performance			
Right hip flexion	3/5	2+/5	MMT for patients with neuromuscular dysfunction: good reliability and validity.[10] Excellent test-retest reliability (r = 0.97-0.98) and interrater reliability.[11]
Right knee flexion	1/5	2+/5	
Right knee extension	2-/5	2-/5	
Right ankle DF	5/5	5/5	
Right ankle PF	5/5	5/5	
Right Knee Pain			
At rest	4/10	2/10	NRS: test-retest reliability is moderate to high (0.67 to 0.96), convergent validity (0.79 to 0.95), criterion validity not yet established[12]
Post-therapeutic exercise	4/10	4/10	
Post-ambulation	4/10	3/10	
Acceptable pain intensity	5/10	5/10	
Sensory Integrity			
Touch awareness of right LE	Sensation diminished along the L1-L4 nerve root distributions likely due to femoral nerve block. Difficult to accurately assess due to bulky post-operative dressing.	Intact throughout	No information on the reliability and validity of a light touch sensation exam could be found. The origin and usage of crude touch, discriminative touch, and pressure perception is described by O'Sullivan and Schmitz.[13]
Tactile localization of right LE	Sensation diminished along the L1-L4 nerve root distributions likely due to femoral nerve block, therefore unable to localize. Difficult to accurately assess due to bulky post-operative dressing.	Intact throughout	
Pressure perception of right LE	Pt able to feel pressure at all locations along all lower extremity nerve root distributions despite femoral nerve block.	Intact throughout	
Right Straight Leg Raise			
	Negative SLR, likely due to femoral nerve block – used KI for out of bed mobility	Negative, ambulated without KI, no buckling seen or reported	No information on the reliability and validity of an active SLR and its ability to determine

			quadriceps strength and the presence of knee buckling in patients who underwent a TKA. However, when trying to increase the level of rectus femoris muscle activity, a straight leg raise should be the exercise of choice when choosing between that and a quad set.[14]

Range of motion (ROM), active assistive range of motion (AAROM), manual muscle testing (MMT), lower extremity (LE), dorsiflexion (DF), plantarflexion (PF), numerical rating scale (NRS), straight leg raise (SLR), knee immobilizer (KI)

Table 3: Post-Operative Total Knee Arthroplasty (TKA) Protocol Progression

Interventions	**Postoperative Day #0 afternoon**	**Postoperative Day #1 morning**	**Postoperative Day #1 afternoon**	**Postoperative Day #2 morning**
Ankle pumps	x 10 reps in supine	x 10 reps in supine	x 10 reps in supine	x 10 reps in supine
Quadriceps sets	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine
Gluteal squeezes	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine	x 10 reps with 5 second hold in supine
Hip abduction and adduction	x 10 reps in supine	x 10 reps in supine	x 10 reps in supine	x 10 reps in supine
Heel Slide	x 10 reps with 5 second hold in supine Max A required	x 10 reps with 5 second hold in supine Max A required	x 10 reps with 5 second hold in supine Mod A required	x 10 reps with 5 second hold in supine Independent
SAQ	x10 reps with 5 second hold in supine Max A required	x10 reps with 5 second hold in supine Max A required	x10 reps with 5 second hold in supine Mod A required	x10 reps with 5 second hold in supine Mod A required
SLR	x10 reps in supine Max A required	x 10 reps in supine Max A required	x10 reps in supine Max A required	x 10 reps in supine Max A required
Seated knee flexion	Not performed	Not performed	Not performed	x 10 reps with 10 second hold
Seated LAQ	Not performed	Not performed	Not performed	x10 reps with 5 second hold Max A required
Seated hip flexion	Not performed	Not performed	Not performed	x 10 reps Mod A required

Seated arm push-ups	Not assessed	Not assessed	Not assessed	x 10 reps

Maximal assist (Max A), moderate assist (mod A), short arc quad (SAQ), straight leg raise (SLR), long arc quad (LAQ)

Table 4: Functional Mobility Outcome Progression during the Acute Care Stay

Functional Outcomes	**Postoperative Day #0 afternoon**	**Postoperative Day #1 morning**	**Postoperative Day #1 afternoon**	**Postoperative Day #2 morning**
Bed mobility assist	HOB elevated Min A with right LE	HOB elevated Supervision	HOB elevated Min A with right LE	HOB flat Independent
Transfer assist (sit-to-stand and stand-to-sit)	CGA with vc's for safe hand placement	CGA with vc's for safe hand placement	CGA with vc's for safe hand placement	Independent
Car transfer assist	Not tested	Not tested	Not tested	Supervision, vc's for sequencing
Ambulation assist	CGA	CGA	CGA	Supervision to independent
Ambulation device	FWW	FWW	FWW	FWW
Ambulation distance	6 M	25 M	25 M	50 M
Ambulation pattern	Step-to gait with vc's for sequencing and use of UE to reduce WB through right LE	Step-to gait	Step-to gait with vc's for sequencing and visual cues for foot placement	Step-to gait

Levels of assist were determined using the functional independence measure (FIM)
Head of bed (HOB), minimal assist (min A), lower extremity (LE), contact guard assist (CGA), = verbal cues (vc's), front wheel walker (FWW), meters (M), upper extremities (UE), weight bearing (WB), lower extremities (LE)

Table 5: Coordination, Communication, Documentation

Coordination	Coordination occurred with the patient's nurse, prior to each visit, to ensure the patient was medically stable, recently medicated, and ready for treatment. The PT also coordinated treatment times with the OT.
Communication	After each therapy visit, information regarding how well the patient performed was communicated back to the patient's nurse and OT. Case management was also consulted to discuss a potential discharge plan and status. PT recommended the patient receive home PT services upon discharge.
Documentation	Each treatment session was documented electronically in the patient's personal health record immediately after each visit.

Table 6: Patient-related Instruction/education

PT POC	On the day of the initial examination, the patient was educated on the role of PT, his PT POC, his impairments, goals, and discharge planning.

Right Knee ROM	The patient and therapist discussed the importance of achieving both knee flexion and extension and was instructed not to prop pillows or towels under his knee while sleeping.
Cryotherapy	Prior to discharge home, the patient was taught how to properly use the cryocuff machine. A cryocuff machine uses both cold and compression to help reduce swelling and regain motion post-operatively.
Discharge	Patient was educated on the importance of pacing his activities and planning ahead, when discharged home, in order to prevent a future injury/fall.
Written handouts	Lower extremity therapeutic exercises and car transfer written handouts were issued.
Equipment	The patient was not provided any equipment upon discharge. The patient owned a hospital bed with bed rails, tub seat, grab bars, and a raised toilet seat. He also owned a standard walker, rollator and SPC, which he had previously used for his left TKA.

PT = physical therapy, POC = plan of care, ROM = range of motion, SPC = single point cane, TKA = total knee arthroplasty

Appendix 1: Patient diagnoses and ICD-9 codes[15]

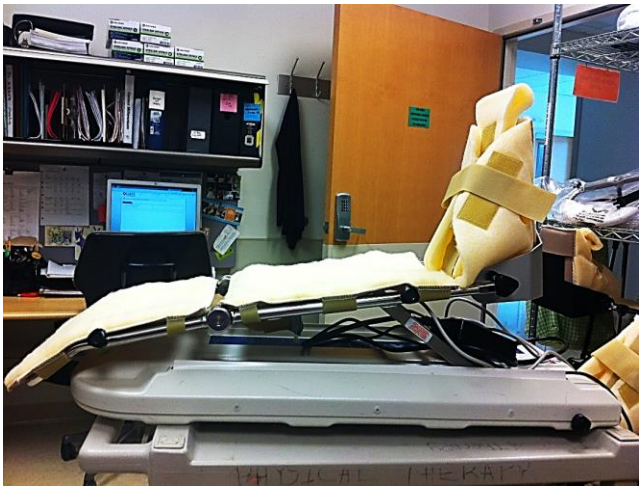
Diagnosis	ICD-9 Code
Osteoarthritis of the right knee	715.96
Right total knee arthroplasty	V43.65
Deconditioning	728.87
Difficulty in walking	719.7
Pain in his limb	729.5

Appendix 2: Physical Therapy Discharge Goals

All goals to be met by post-operative day two:	
1	Patient will be independent with bed mobility (head of bed flat, no use of bed rails), transfers, and gait x40 meters with use of a front wheel walker and no loss of balance in order to safely return home.
2	Patient will achieve right knee ROM 0-90 degrees in order to be able to be able to go from sit-to-stand and stand-to-sit without assistance.
3	Patient will consistently perform a positive right lower extremity straight leg raise in order to ensure full quadriceps function for safe weight-bearing mobility.
4	Patient will demonstrate good understanding/verbalization/performance of fall prevention strategies, home safety/mobility and right lower extremity therapeutic exercises per TKA protocol in order to ensure safe discharge home.

Appendix 3: Cryocuff

Appendix 4: Continuous Passive Motion (CPM) Machine



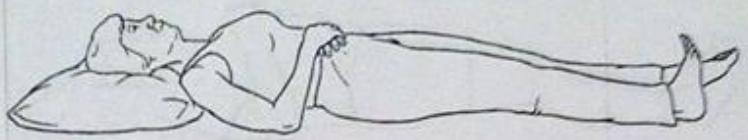
Appendix 5: Car Transfer Simulator

Appendix 6: Post-Operative Total Knee Arthroplasty (TKA) Protocol:

[redacted] ORTHOPAEDIC INSTITUTE

Routine For: [redacted]
Created By: [redacted] TOTAL KNEE REPLACEMENT ESSENTIAL EXERCISES

1. ANKLE PUMP



While lying down, point your toes up to the ceiling and then point down as far as you can go. Repeat on the other foot.

Before surgery: Repeat 10 times. Do 3 sessions per day.

After surgery: Repeat 10 times. Do every hour.

2. THIGH EXERCISES
(to strengthen muscles on front of thigh)

With operative leg straight, slowly tighten the muscles of your thigh while pushing the back of the knee down into the bed. The muscles on the front of the thigh should tighten. Count out loud to 5, then relax. Repeat with other leg.

Before surgery: Repeat 10 times. Do 3 sessions per day.

After surgery: Repeat 10 times, each leg. Do every hour.

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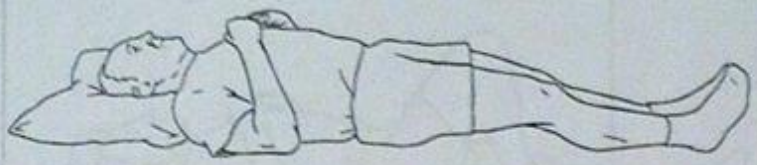
[redacted] ORTHOPAEDIC INSTITUTE

Routine For:
Created By: [redacted] TOTAL KNEE REPLACEMENT ESSENTIAL EXERCISES [redacted]

3. GLUTEAL SQUEEZE

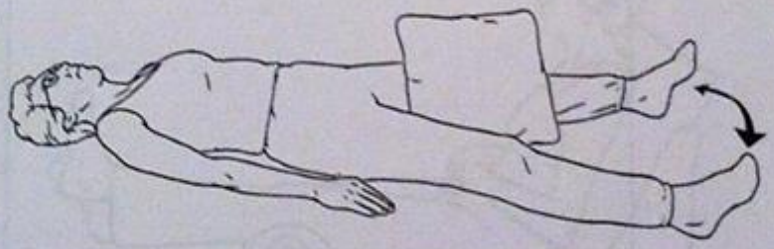


Squeeze buttocks muscles as tightly as possible while counting out loud to 5 and then relax.

Before surgery: Repeat 10 times. Do 3 sessions per day.

After surgery: Repeat 10 times. Do every hour.

4. INNER & OUTER THIGH EXERCISES



While lying down, slide one leg out to side. Keep kneecap pointing up. Gently bring leg back to pillow. Repeat with other leg.

Repeat 10 times. Do 3 sessions per day.

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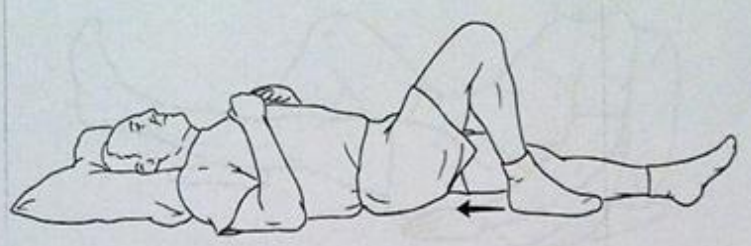
[redacted] ORTHOPAEDIC INSTITUTE

Routine For:
Created By: [redacted] TOTAL KNEE REPLACEMENT ESSENTIAL EXERCISES [redacted]

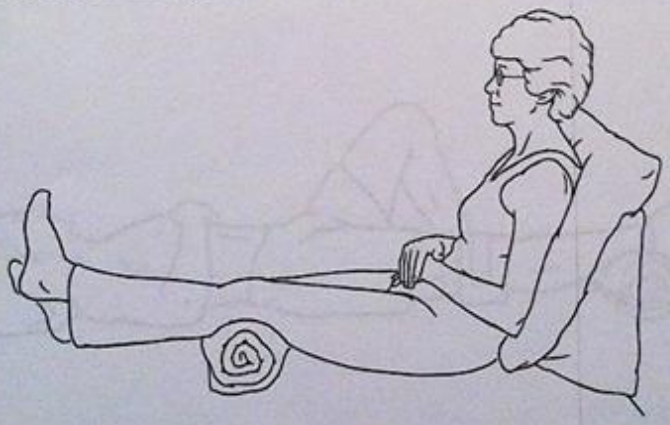
5. HEEL SLIDE



Lie on back, bend knee by sliding heel toward your buttocks. Pause and return to starting position.

Repeat 10 times (each leg), 3 times per day.

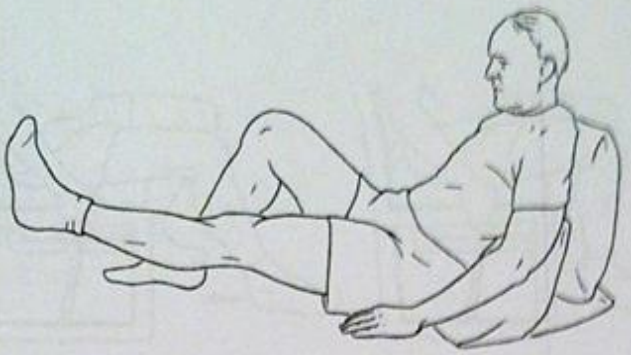
6. SHORT ARC QUAD



Place a large can or rolled towel under operative knee. Straighten knee slowly lifting foot off of the bed while keeping back of knee on the towel roll. Hold 5 seconds.

Repeat 10 times (each leg). Do 3 sessions per day.

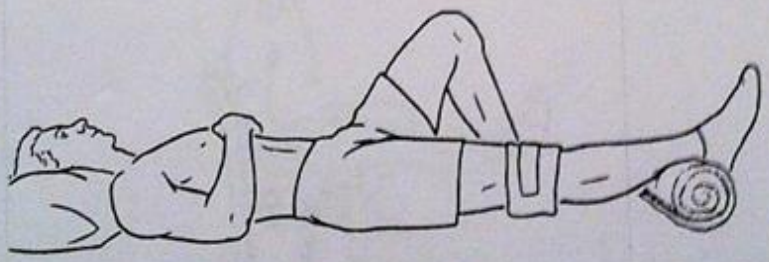
7. STRAIGHT LEG RAISE



Bend one leg. Keep other leg as straight as possible and tighten muscles on top of thigh. Slowly lift straight leg 6 inches from surface of bed, keeping knee straight as you lift. Pause and then slowly lower your leg back to the surface of the bed.

Repeat 10 times (each leg). Do 3 sessions per day.

9. Knee Extension Mobilization: Towel Prop



After surgery: Place rolled towel under the ankle of your surgical leg. Hold for 15 - 30 minutes.

Do 3 times per day.

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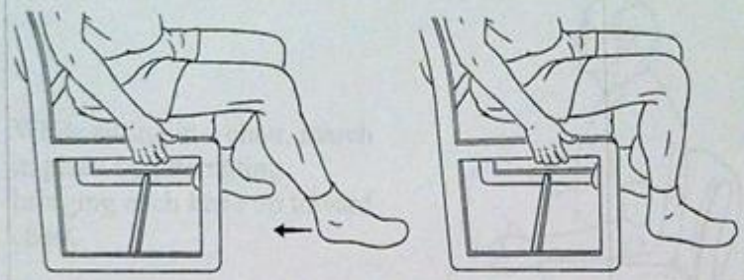
10. KNEE FLEXION



Place foot of operative leg on smooth surface. Slowly slide foot back as far as possible bending your knee. Hold up to 30 seconds. Then return leg to the starting position.

Repeat 10 times. Do 3 sessions per day.

11. LONG ARC QUAD

While sitting in chair, straighten knee of operative leg and hold it 5 seconds. Then slowly return to the starting position.

*Do not use a weight on your ankle.

Repeat 10 times. Do 3 sessions a day.

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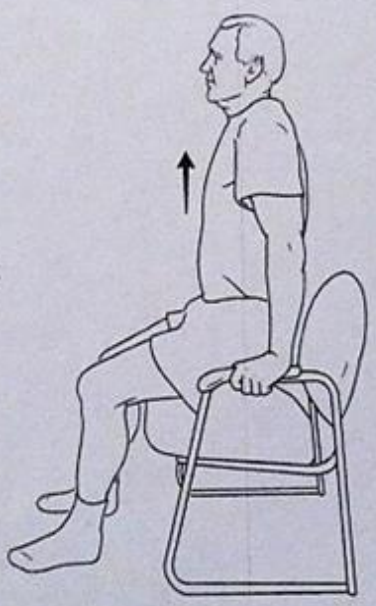
12. SEATED HIP FLEXION

While sitting in a chair, march in place by alternating bringing each knee up toward chest.

Repeat 10 times.
Do 3 sessions per day.

13. ARM PUSH UP

Put hands on arms of chair and push body up out of chair.



Repeat 10 times.
Do 3 sessions per day.